

## Overview of plasma-wall interaction studies during the first He mini-campaign in EAST with a tungsten divertor

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Helium (He) plasmas are currently foreseen in the ITER non-active operation phases due to the generally observed lower H-mode power threshold in He compared to hydrogen. However, high He fluxes on tungsten (W) materials can induce strong morphology such as fuzz and nano-bubbles. Studying the impact of He plasma operation on W plasma-facing components (PFC) and the general characteristics of He tokamak discharges in all-metal PFC environments is a high priority for development of the ITER Research Plan.

One week of He operation has recently been successfully performed on EAST equipped with an upper ITER-like, water cooled, W monoblock divertor. The discharges obtained comprise an extensive set of pure RF-heated, H-mode plasmas with different types of ELMs. The H-mode power threshold is found to be ~50% higher than the 2008 scaling law in deuterium (D) plasma for an electron density  $> 3.2 \times 10^{19} \text{ m}^{-3}$ , increasing rapidly towards lower density. The energy confinement and pedestal characteristics are strongly dependent on the He purity. High performance Type-I ELMy H-modes can only be achieved for He concentrations  $C_{\text{He}} < 60\%$ . Both resonant magnetic perturbations and boron powder injection are demonstrated to suppress ELMs effectively.

Divertor detachment in He plasma has been achieved by both density ramps and neon impurity seeding. The detachment threshold density is significantly increased with increasing heating power,  $P_{\text{RF}}$  and is higher than for equivalent D discharges at the same  $P_{\text{RF}}$ . The global recycling coefficient of He measured by particle balance increases with  $P_{\text{RF}}$ , and is higher than D. The He pumping speed is relatively low compared to D, and can be slightly improved by moving the strike point close to the cryopump. For W erosion studies, it is found that the ELM-averaged W erosion rate by He plasma increases nearly linearly with  $P_{\text{RF}}$ , similar to D plasmas. The intra-ELM W sputtering source shows a strong positive correlation with the ELM frequency, similar to findings in DIII-D.

Three dedicated He experiments with sample exposures have been successfully carried out using the outboard midplane manipulator MAPES. Two sets of He pre-exposed W samples have been used to study material erosion and fuzz formation features. To understand material migration in magnetically shadowed regions at the first wall panels in ITER, a proxy tile with two different material coatings, carbon and aluminium, on different sides of the plasma wetted area, have been exposed in L-mode He plasma, thus avoiding the effects of chemical erosion. A known quantity of  $^{13}\text{CD}_4$  was injected and traced using graphite samples in both He and D plasmas to study the effect of chemical erosion on redeposited layers.